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(19)

(54) IMPROVEMENTS IN OR RELATING TO ELECTRO-ACOUSTIC TRANSDUCERS

(71) We A.R.D. ANSTALT, of P.O. Box 34.613, 9490 Vaduz, Liechtenstein, a body corporate organised under the laws of Liechtenstein, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly rescribed in and by the following statement:—

The invention relates to electro-acoustic transducers.

Conventionally, electro-magnetic-acoustic transducers comprise a diaphragm provided with a tubular former on which a voice coil is wound, the diaphragm being mounted in a chassis to which a permanent magnet structure is fixed. The magnet structure provides an annular gap within which the voice coil is received. The transducer can be regarded as comprising a diaphragm, a chassis, and an electro-mechanical transducer consisting of the voice coil and former and the magnet structure. If the transducer is used as a loudspeaker, electrical energy is supplied to the voice coil to cause this to move axially together with the diaphragm, the movement of which generates sound vibrations. If used as a microphone, sound vibrations cause the diaphragm to move so that the voice coil moves also and develops electrical energy in a circuit connected to the microphone terminals. The structure of such electro-acoustic transducers imposes limitations on the accuracy with which an electrical input signal is converted to sound when the transducer is used as a loudspeaker. Thus because the electro-mechanical transducer acts centrally there is a tendency for the diaphragm to change its configuration under the mechanical stresses developed as it moves in response to the electro-mechanical transducer drive, particularly due to signals of complex frequency composition.

The invention accordingly provides an electro-acoustic transducer comprising a diaphragm, a chassis, at least one electro-mechanical transducer operative between the diaphragm and the chassis, and a plurality of electromagnet devices separate from and independent of the at least one electro-mechanical transducer and arranged to effect damping, centering or suspension of the diaphragm.

The diaphragm may be annular or circular and the electromagnetic devices can then be equiangularly distributed about a circle concentric with the diaphragm.

As compared with conventional loudspeaker units of the same overall dimensions, such a transducer can provide the advantage that the distance between the suspension means and the speech coil of the or each electromechanical drive transducer is reduced, so that the tendency of the diaphragm to bend in use because of the restraints imposed by the suspension are diminished. Moreover the electromechanical transducers and the electromagnetic devices can be of like construction, so it is possible to provide only a single design of speech coil/magnet assembly for use with a variety of electro-acoustic transducers of a variety of forms.

The electro-acoustic transducer unit of the invention can be constructed with a diaphragm formed conventionally from sheet material. The diaphragm design is preferably such as to minimize weight and aerodynamic resistance to movement and to maximise rigidity and thus resistance to distortion in use.

The invention is further described below, by way of example, with reference to the accompanying schematic drawing, in which:

Figure 1 is a side view of a first electro-acoustic transducer embodying the invention;

Figure 2 is a frontal view of a second electro-acoustic transducer embodying the invention;

Figure 3 is a fragmentary side view of a third electro-acoustic transducer embodying the invention; and

Figure 4 is a frontal view of a fourth electro-acoustic transducer embodying the invention.

The electro-acoustic transducer 1, illustrated in Figure 1, comprises a chassis 2 in which is suspended a circular diaphragm 4. The diaphragm 4 is located at the lower part

of the chassis 2 and is driven by a plurality of electro-mechanical transducers 6. The chassis 2 extends outwardly beyond the diaphragm 4 to mount a second, generally frusto-conical, diaphragm 8 by means of a conventional annular suspension member 10 having an annular corrugation or groove. The diaphragm 8 is connected at its narrower end with the diaphragm 4 so as to be concentric therewith.

The diaphragm 4 could be annular if preferred and as it functions primarily to support the sound radiating diaphragm 8, it may be apertured. The diaphragm 8 could have a straight-edge frusto-conical form instead of the curved sides illustrated.

The transducer 1 also has electro-magnetic damping or braking means 12 carried at the outer edge of the diaphragm 8.

The second electro-acoustic transducer 21, shown in Figure 2, has a diaphragm 22 mounted in a chassis 24 by a suspension 26. The diaphragm 22 has secured thereto a plurality of voice coils 28 each of which is part of an electro-magnetic transducer comprising also a magnet (not shown) mounted on the chassis 24. These electromagnetic transducers serve to drive the diaphragm 22. In order to distribute the motor function so as to minimise stress in the diaphragm 22, the voice coils 28 are mounted at positions equiangularly spaced around a circle 30 concentric with the diaphragm axis. This circle 30 is preferably of a radius greater than half the radius of the diaphragm 22. Between each adjacent pair of voice coils 28, an electromagnetic damping or braking means 32 is positioned on the circle 30 as shown.

The electromagnetic damping or braking means 12, 32 shown in Figures 1 and 2 comprise coils carried by the respective diaphragms in the same manner as voice coils, each coil being received in a respective gap in a permanent magnet structure again in the same way as a voice coil.

The electromagnetic means 12, 32 can function as centering means or can replace or supplement conventional diaphragm suspension means. Thus an electro-magnetic suspension system can comprise a plurality of coils as shown in Figure 2, carried at the periphery of the diaphragm at equiangularly spaced positions say 45° to 90° apart.

Although shown in Figure 2 as having a smaller diameter than the voice coils 28, the coils of the electromagnetic means 32 can be larger or of the same diameter, and the electromagnetic means can be identical with the electro-mechanical transducers including the coils 28.

Figure 3 shows an alternative electromagnetic device comprising a coil 32 and magnetic structure 34 at the edge of a diaphragm 36 by which the diaphragm is suspended in a chassis 38. It is of course possible within the invention to combine conventional suspension means and an electromagnetic suspension as described herein for use in mounting a diaphragm in an electro-acoustic transducer. By appropriate selection, it will be seen to be possible to provide a mounting arrangement for a diaphragm in an electro-acoustic transducer which approaches the ideal of a free piston-like movement, without deformation, and without in any way inhibiting movement even for large excursions at high power.

The transducer 21 can be employed either as a loudspeaker or as an auxiliary radiator pneumatically coupled with a loudspeaker, the electro-mechanical transducers 28 then providing outputs which can be used to power one or more other loudspeakers or for monitoring and control purposes. The transducer 21 can be used in either role in association with an annular diaphragm 42 as shown in Figure 4. The diaphragm 42 is mounted by suspensions 44 in a chassis 46 which may be common with or, as shown, connected to the chassis 24. Depending on the function of the diaphragm 42, it may be provided with electromechanical transducers 48, preferably, as shown, equiangularly arranged around a concentric circle of a radius which is an average of the inner and outer radii of the diaphragm 42.

It will be evident that a variety of transducers with different diaphragm configurations can be produced in accordance with the invention. The units need not be externally circular but could be elliptical or have some other desired shape. Thus, the invention can be embodied in a variety of transducers other than as described, and the transducers described can be modified in various ways, within the scope of the invention as defined by the following claims.

WHAT WE CLAIM IS:—

1. An electro-acoustic transducer comprising a diaphragm, a chassis, at least one electromechanical transducer operative between the diaphragm and the chassis, and a plurality of electro-magnetic devices separate from and independent of the at least one electromechanical transducer and arranged to effect damping, centering or suspension of the diaphragm.

2. An electro-acoustic transducer as claimed in claim 1 wherein the diaphragm is annular or circular and the electromagnet devices are equiangularly distributed about a circle concentric with the diaphragm.

3. An electro-acoustic transducer as claimed in claim 2 having a plurality of the electromechanical transducers equiangularly distributed about the circle.

4. An electro-acoustic transducer as claimed in claim 2 wherein the plurality of electromagnetic devices are located at the periphery of the diaphragm.

5. An electro-acoustic transducer as claimed in claim 4 wherein the diaphragm comprises a planar portion having a plurality of the electromechanical transducers acting on one side thereof, and a flared portion flaring outwardly from the other side of the planar portion, the electromagnetic devices being located at the periphery of the flared portion.

6. An electro-acoustic transducer as claimed in any preceding claim wherein each electromagnetic device comprises a coil connected to the diaphragm and a magnet structure receiving the coil to suspend the diaphragm in the chassis.

7. An electro-acoustic transducer as claimed in claim 6 wherein each electromagnetic device is identical with the at least one electromechanical transducer.

8. An electro-acoustic transducer substantially as herein described with reference to Figure 1, Figure 2, Figure 3 or Figure 4 of the accompanying drawing.

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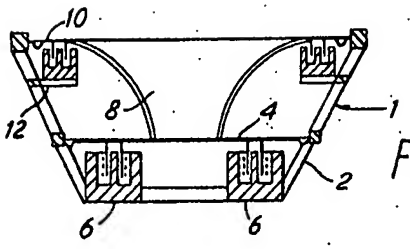

FIG.1

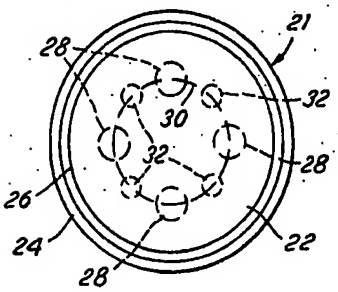

FIG.2

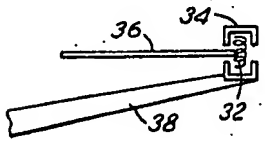

FIG.3

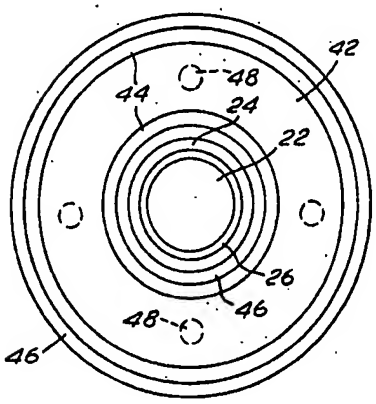

FIG.4